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Title of the Invention

WIRELESS LAN ACCESS POINT APPARATUS

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## WIRELESS LAN ACCESS POINT APPARATUS

## BACKGROUND OF THE INVENTION

## FIELD OF THE INVENTION

The present invention generally relates to a wireless LAN (Local Area Network) system. More particularly, the present invention is concerned with an access point apparatus for measuring or determining the current location or position of a mobile terminal in the wireless LAN system by making use of a radio signal. Incidentally, the access point apparatus may also be referred to as the access point station or base station in more general terms.

## DESCRIPTION OF THE RELATED ART

For better understanding of the concept underlying the present invention, description will firstly be made of background techniques of the invention. As a method of measuring or determining the current location of a terminal with the aid of a radio signal used in the wireless LAN system, there can be mentioned a method which is disclosed in A. Ogino et al's article "INTEGRATED WIRELESS LAN ACCESS SYSTEM, (1) STUDY ON LOCATION SYSTEM" in "The Collection of Lecture Drafts in the General Convention of The Institute of Electronics, Information and Communication Engineers in Japan (2003)", B-5-203, p.662. In the

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following, description will be made of the configuration and operation of the wireless LAN access point apparatus (base station) disclosed in the Ogino et al reference.

5               Figure 9 of the accompanying drawings is a schematic diagram which shows, by way of example, a configuration of a wireless LAN system equipped with a terminal locating facility (i.e., function for determining a location or position of a terminal). A  
10               plurality of access point apparatuses or base stations (e.g. three access point apparatuses 1, 2 and 3 in the case of the LAN system illustrated in Fig. 9) are connected to a server 6 by way of a network 5 constituted by a public network and a mobile  
15               communication network. The terminal denoted by reference numeral 4 performs transaction of information or data with the server 6 through the medium of these access point apparatuses or base stations.

              A processing flow for determining the  
20               location of the terminal 4 in the LAN system shown in Fig. 9 will be described below. The terminal 4 transmits or sends a radio signal. The access point apparatuses or base stations 1, 2 and 3 receive the radio signal to execute the signal processing which is  
25               required for determining the location of the terminal. In addition, each of the access point apparatuses 1 to 3 informs the server 6 of the result of the above-mentioned signal processing as executed via the network

5. On the basis of the signal processing result received from the individual access point apparatuses or stations, the server 6 arithmetically determines the location of the terminal 4.

5                Figure 10 of the accompanying drawings is a block diagram showing generally a structure of a hitherto known or conventional access point apparatus for realizing the processing flow mentioned above. Referring to the figure, a signal receiving unit 101 is  
10 designed to perform a reception processing at a high/intermediate frequency corresponding to the radio signal received via an antenna 100, a demodulation processing of a base-band signal and an AD conversion (Analog to Digital conversion) to thereby generate a  
15 received signal.

On the other hand, a received signal memory control module 106 is so designed or programmed as to perform an access control for storing the received signal generated by the signal receiving unit 101 in a  
20 received signal memory 102 in response to a capture start command messaged from a terminal location determining signal processing module 103 via a signal line 104. In that case, the received signal memory control module 106 holds as a capture start timing the  
25 timing which is indicated by a clock 107 when storage of the received signal in the received signal memory 102 is started. In this conjunction, the clock 107 may be constituted, for example, by a counter which

operates under the timing of a clock signal used in the access point apparatus.

Next, referring to Figs. 11 and 12 of the accompanying drawings, description will turn to an access control method carried out by the received signal memory control module 106 in the conventional access point apparatus or station. It is assumed that the storage of the received signal is started at a timing  $T_{p0}$  shown in Fig. 11. In that case, the received signal memory control module 106 firstly stores the timing  $T_{p0}$  as the capture start timing. In addition, the received signal memory control module 106 stores the received signal at the timing  $T_{p0}$  in the received signal memory 102 at an address  $A_{p0}$ , as shown in Fig. 12. In this conjunction, the address  $A_{p0}$  may be a predetermined address or alternatively it may be designated by the terminal location determining signal processing module 103 upon issuance of the capture start command from the terminal location determining signal processing module 103. In succession, the received signal memory control module 106 carries out the access control such that the received signal is stored sequentially in the received signal memory 102 at the addresses  $A_{p0+1}$ ,  $A_{p0+2}$ , ... in this order, as is illustrated in Fig. 12. When the received signal has been stored up to the address  $A_{p1}$  in the received signal memory 102, the received signal memory control module 106 terminates or ends the process of storing the

received signal in the received signal memory 102.  
Incidentally, the address  $A_{p1}$  may be a predetermined  
address or alternatively it may be designated by the  
terminal location determining signal processing module  
5 103 when the received signal capture start command is  
issued by the terminal location determining signal  
processing module 103.

Upon completion of the storage of the  
received signal in the received signal memory 102, the  
10 received signal memory control module 106 sends a  
received signal capture end message and the capture  
start timing to the terminal location determining  
signal processing module 103 via a signal line 105.

Upon reception of the capture end message  
15 mentioned above, the terminal location determining  
signal processing module 103 executes the signal  
processing required for arithmetically determining the  
location of the mobile terminal on the basis of the  
received signal stored in the received signal memory  
20 and the capture start timing mentioned above, the  
result of the signal processing being then messaged or  
transferred to the server 6 shown in Fig. 9. As the  
signal processing required for the arithmetic  
determination of the location or position of the mobile  
25 terminal, there can be mentioned a processing for  
arithmetically determining the reception timing of the  
signal sent from the terminal, a processing for  
arithmetically determining a delay profile for the

determination of the reception timing, etc.. In this  
conjunction, it should be added that a matched filter,  
for example, may be employed for the arithmetic  
determination of the delay profile. Further, for  
5 arithmetically deriving the reception timing of the  
received signal from the delay profile as obtained, a  
method disclosed in e.g. JP-A-2002-14152 may be  
adopted. Alternatively, the received signal stored in  
the received signal memory 102 may be intactly  
10 transferred to the server 6 without executing any  
particular processing on the received signal stored in  
the received signal memory 102.

The server 6 then arithmetically determines  
the location or position of the terminal on the basis  
15 of the results of the signal processings sent from the  
individual access point apparatuses (base stations) 1,  
2 and 3 by resorting to, for example, a trilateration  
method described, for example, in the Ogino et al  
reference cited hereinbefore.

## 20 SUMMARY OF THE INVENTION

The wireless LAN system is a packet  
communication system. Consequently, a packet signal  
exists locally within a certain or given time zone and  
does not exist in the other time zone. Under the  
25 circumstances, there may arise such situation that with  
the hitherto known or conventional access point  
apparatus such as described above, the packet signal

sent to the access point apparatuses from the terminal 4 for the location determination thereof can not be stored in the received signal memory 102. By way of example, in the case of a situation illustrated in Figs. 13, the access point apparatus stores the received signal in the received signal memory 102 during a period or session extending from a point  $T_{p2}$  to a timing  $T_{p3}$ . However, a packet signal 200 sent from the terminal 4 exists within a time zone extending from a timing  $T_{p4}$  to a timing  $T_{p5}$ . Consequently, the received signal containing the packet signal 200 can not be stored in the received signal memory 102. In general, in the packet communication, the delay time may remarkably vary in dependence on increase/decrease or change of the traffic volume in the communication channel. For this reason, the situation in which the delay time of the packet increases will frequently take place, incurring such undesirable situation as illustrated in Fig. 13. In that case, the relevant access point apparatus or station is incapable of sending to the server 6 the information useful for determination of the terminal location, as a result of which accuracy and reliability of the terminal locating arithmetic procedure executed by the server 6 will suffer degradation.

For coping with the problem mentioned above, there may be conceived a method of storing in the received signal memory 102 the received signal of a

temporal duration lengthened to an extent sufficient for absorbing the variation of the delay time of the packet signal. By way of example, by capturing the received signal over the period or session (from the timing  $T_{p6}$  to  $T_{p7}$ ) long enough to cover the variation of the packet delay time, as is illustrated in Fig. 14, the packet signal 200 (having a duration  $T_{p8}$  to  $T_{p9}$ ) sent from the terminal for determination of the location thereof can be stored in the received signal memory 102. In this conjunction, the contents of the received signal stored in the received signal memory 102 are illustrated in Fig. 15. It can be seen that in the received signal stored in the received signal memory 102, the packet signal 200 exists only in the memory space delimited by the addresses  $A_{p8}$  and  $A_{p9}$  inclusive, while in the other memory spaces (addresses  $A_{p6}$  to  $A_{p8-1}$  and  $A_{p9+1}$  to  $A_{p7}$ ), there exists no signals except noise signals. The signal which can be used for determination of the location of the terminal is only the packet signal 200. Consequently, the memory space in which the noise signals are stored can not contribute to the location determination of the terminal. This means that the utilization efficiency of the received signal memory 102 is degraded. As a consequence, the memory capacity demanded by the access point apparatus or base station increases correspondingly, which in turn incurs increase of the cost involved in implementation and operation or

running of the access point apparatus, and hence cost  
of the location information service provided by the  
wireless LAN system will eventually increase, whereby  
convenience of the location information service is  
5 lowered.

The related art of the invention which has  
been described by reference to Figs. 9 to 15, however  
does not mean admission in the U.S. statute.

Thus, in light of the state of art described  
10 above, an object of the present invention is to provide  
an improved access point apparatus in which the  
problems mentioned above are successfully and  
satisfactorily solved.

In view of the above and other objects which  
15 will become apparent as the description proceeds, there  
is provided according to a general aspect of the  
present invention an access point apparatus for a  
terminal locating system for determining a location of  
a terminal on the basis of a timing at which a radio  
20 packet signal sent from the terminal is received.

The access point apparatus mentioned above  
comprises a signal receiving unit for receiving the  
radio packet signal to thereby generate a received  
signal, a received signal memory for storing the  
25 received signal, a packet detection module for  
detecting a packet contained in the generated received  
signal, a received signal memory control module for  
performing a received signal write control for writing

the received signal in the received signal memory from the signal receiving unit and a read control unit for reading out the received signal from the received signal memory, and a clock for correlating the received  
5 signal and time in the access point apparatus.

The received signal memory control module is so arranged as to perform such control that the received signal is written in the received signal memory sequentially from a first address and after  
10 writing of the received signal in the received signal memory at a second address, the received signal is again written in the received signal memory sequentially from the first address while writing of the received signal in the received signal memory is  
15 stopped in response to detection of a packet contained in the received signal by the packet detecting module.

The reception timing of the radio packet signal is determined on the basis of the received signal readout and the time in the wireless LAN access  
20 point apparatus.

With the arrangement of the access point apparatus according to the present invention described above, the received signal memory control module is so designed as to control the access made to the access  
25 point apparatus (base station) such that the memory space can be reused by sequentially performing overwrite operation on the received signal memory. In addition, the received signal memory control module is

designed to stop capturing of the received signal in response to the packet detection signal issued by the packet detecting means.

The above and other objects, features and attendant advantages of the present invention will more easily be understood by reading the following description of the preferred embodiments thereof taken, only by way of example, in conjunction with the accompanying drawings.

#### 10 BRIEF DESCRIPTION OF THE DRAWINGS

In the course of the description which follows, reference is made to the drawings, in which:

Fig. 1 is a block diagram showing generally and schematically a circuit configuration of a wireless LAN access point apparatus to which the present invention is applied;

Fig. 2 is a view for illustrating a method of accessing a received signal memory in the above-mentioned wireless LAN access point apparatus;

Fig. 3 is a view for illustrating a packet detection in a capture stop method according to a first embodiment of the present invention;

Fig. 4 is a view for illustrating a method of accessing a received signal memory in the capture stop method according to the first embodiment of the present invention;

Fig. 5 is a view for illustrating a packet

detection in the capture stop method according to a second embodiment of the present invention;

Fig. 6 is a view for illustrating a method of accessing the received signal memory in the capture  
5 stop method according to the second embodiment of the present invention;

Fig. 7 is a view for illustrating a packet detection in the capture stop method according to a third embodiment of the present invention;

10 Fig. 8 is a view for illustrating a method of accessing the received signal memory in the capture stop method according to the third embodiment of the present invention;

Fig. 9 is an view for illustrating an example  
15 of a wireless LAN system equipped with a terminal location determining facility, to which the present invention is applied;

Fig. 10 is a block circuit diagram showing a conventional wireless LAN access point apparatus;

20 Fig. 11 is a view for illustrating a conventional received signal capturing method;

Fig. 12 is a view for illustrating a conventional method of accessing a received signal memory;

25 Fig. 13 is a view for illustrating a case where no packet exists in a capture session;

Fig. 14 is a view for illustrating a case where a packet exists within the capture session; and

Fig. 15 is a view for illustrating a state where the received signal memory is used in the conventional wireless LAN access point apparatus.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

5           The present invention will be described in detail in conjunction with what is presently considered as typical embodiments thereof by reference to the drawings.

          Figure 1 shows generally and schematically a  
10 configuration of the access point apparatus (base station) to which the teachings of the present invention are applied. In the figure, components same as or equivalent to those described hereinbefore in conjunction with the conventional access point  
15 apparatus are denoted by like reference numerals. At this juncture, it should be firstly be mentioned that implementation of the signal receiving unit in the access point apparatus or station is not always essential for the present invention. It is sufficient  
20 for realization of the present invention that the terminal unit is so arranged as to make use of the reception timing of the down-link radio signal, as will become apparent as the description proceeds. Referring to Fig. 1, a signal receiving unit 101 performs a  
25 reception processing at a high/intermediate frequency corresponding to the radio signal received via an antenna 100, a demodulation processing of a base-band

signal and an AD (Analog-to-Digital) conversion to thereby generate a received signal.

A received signal memory control module 120 starts to capture the received signal generated by the signal receiving unit 101 in a received signal memory 102 in response to a capture start command issued by a signal processing module for terminal location determination 103 and transmitted via a signal line 104. A method of writing the received signal in the received signal memory 102 by means of a received signal memory control module 120 is shown in Fig. 2. As can be seen from this figure, the received signal memory control module 120 firstly writes the received signal sequentially in a memory space extending from a leading write address  $A_0$  to an address  $A_{N-1}$ . Upon completion of writing of the received signal up to the address  $A_{N-1}$ , the received signal memory control module 120 carries out an access control for the received signal memory 102 so that the succeeding received signal is written at the address  $A_0$ . The received signal memory control module 120 repeats the operation mentioned above. In this manner, the access control for the received signal memory 102 is executed such that the received signal is repetitionally written in the memory space extending from the address  $A_0$  to the address  $A_{N-1}$ , as is illustrated in Fig. 2.

The received signal memory control module 120 stops the capture of the received signal in the

received signal memory 102 upon reception of a packet  
detection signal issued by a packet detecting module  
121. By virtue of this method, the packet can be  
stored with high efficiency with a small memory  
5 capacity independently of the length of the time period  
during which the received signal is captured. Thus, so  
far as the memory capacity is equivalent to at least  
one packet or equivalent to the signal length required  
for determining the reception timing of the packet, the  
10 position or location of the terminal can be detected by  
carrying out the packet communication according to the  
method of the present invention. Even when the time  
and margin involved in the packet detection processing  
is taken into account, the memory capacity about twice  
15 as large as that of the packet will be sufficient for  
the determination of the terminal location.

Now referring to Figs. 3 and 4, description  
will be directed to a method of stopping the capture of  
the received signal through cooperation of the packet  
20 detecting module 121 and the received signal memory  
control module 120 according to a first embodiment of  
the present invention. As shown in Fig. 3, the packet  
detecting module 121 is designed to detect a leading  
portion or edge of a packet signal 201 arrived at the  
25 access point apparatus (base station) at a timing  $T_s$  and  
message the detection of the packet head to the  
received signal memory control module 120. For  
detecting the leading edge of the packet signal, there

can be mentioned a method of making decision as to whether or not the received power increases steeply beyond a threshold value, to thereby determine the detection of the leading edge of the packet signal when  
5 the threshold value is exceeded. Alternatively, such a detection method may equally be adopted according to which a correlation value of the received signal and a predetermined preamble pattern is arithmetically determined by using e.g. a matched filter or the like  
10 for thereby detecting a preamble affixed to the leading of the packet signal. Upon reception of the message informing the detection of the packet head from the packet detecting module 121, the received signal memory control module 120 stops capturing the received signal.  
15 This operation will be elucidated below by reference to Fig. 4. It is assumed that a received signal of the leading edge (the timing  $T_s$ ) of the packet signal 201 which is detected by the packet detecting module 121 is written in the received signal memory 102 at an address  
20  $A_s$ , as shown in Fig. 4. In response to reception of the message informing the detection of the packet head, the received signal memory control module 120 executes writing of the received signal up to an address  $A_{s-1}$  in accordance with the access control method described  
25 previously by reference to Fig. 2, whereupon capturing of the received signal is terminated. Furthermore, the received signal memory control module 120 records as a packet head address the address  $A_s$  at which the received

signal is written at the timing when the message of detection of the packet head is received from the packet detecting module 121. Moreover, the received signal memory control module 120 records as a packet head timing the timing  $T_s$  indicated by the clock 107 at the timing when the message of detection of the packet head is received from the packet detecting module 121. In this conjunction, it should also be added that the received signal memory control module 120 may be so arranged as to record instead of recording the timing  $T_s$  a timing indicated by the clock 107 when capturing of the received signal was started and a count value resulting from counting the number of times the received signal has been written at the address  $A_0$  during the period or session from the start of capturing the received signal to the end thereof.

Next, referring to Figs. 5 and 6, description will be directed to the method of stopping the capture of the received signal effected through cooperation of the packet detecting module 121 and the received signal memory control module 120 according to a second embodiment of the present invention. As shown in Fig. 5, the packet detecting module 121 is designed to detect a trailing portion or edge of a packet signal 202 arrived at the access point apparatus (base station) and message the detection of the packet end to the received signal memory control module 120. For detecting the trailing edge of the packet signal, there

can be mentioned a method of making decision as to whether or not the received power decreases steeply below a threshold value, to thereby determine the detection of the trailing edge of the packet signal

5 when the received power becomes lower than the threshold value. Upon reception of the message informing the detection of the packet end from the packet detecting module 121, the received signal memory control module 120 stops capturing the received signal.

10 This operation will be elucidated below by reference to Fig. 6. The received signal memory control module 120 is so designed that when the received signal of the trailing edge (timing  $T_E$ ) of the packet signal 202 as detected by the packet detecting module 121 is written

15 in the received signal memory 102 at an address  $A_E$ , as shown in Fig. 6, capturing of the received signal is immediately terminated. Furthermore, the received signal memory control module 120 records as a packet end address the address  $A_E$  at which the received signal

20 is written at the timing when the message of detection of the packet end was received from the packet detecting module 121. Moreover, the received signal memory control module 120 records as a packet end timing the timing  $T_E$  indicated by a clock 107 when the

25 message of detection of the packet end was received from the packet detecting module 121. In this conjunction, it should also be added that the received signal memory control module 120 may be so arranged as

to record instead of the timing  $T_e$  a timing indicated by the clock 107 when capturing of the received signal was started and a count value resulting from counting the number of times the received signal has been written at the address  $A_0$  during the period or session the start of capturing the received signal to the end thereof.

Referring to Figs. 7 and 8, description will be directed to the method of stopping the capture of the received signal effected through cooperation of the packet detecting module 121 and the received signal memory control module 120 according to a third embodiment of the present invention. Referring to Fig. 7, the packet detecting module 121 detects a packet signal 203 arrived at the access point apparatus (base station) at an intermediate portion of the packet (timing  $T_p$ ) and messages the detection of the packet to the received signal memory control module 120. For detecting the packet at the intermediate portion thereof, as mentioned above, there can be adopted, for example, a method of monitoring the received signal power for a predetermined period and making decision as to whether or not a mean value of the received power exceeds a threshold value. When the mean value of the received power exceeds the threshold value, it can then be decided that the packet signal has been detected. Upon reception of the message informing the detection of the packet signal from the packet detecting module 121, the received signal memory control module 120

stops capturing the received signal. This operation will be elucidated below by reference to Fig. 8. At this juncture, it is assumed that the received signal at the timing ( $T_p$ ) at which the packet signal 203 was  
5 detected by the packet detecting module 121 has been written in the received signal memory 102 at an address  $A_p$ , as shown in Fig. 8. In response to the message of the packet detection, the received signal memory control module 120 writes the received signal  
10 additionally at  $L$  addresses in accordance with the access control method described hereinbefore by reference to Fig. 2, whereupon capture of the received signal comes to an end. Thus, the final address at which the received signal has been written is  
15 represented by " $\text{mod}(A_p + L, N)$ ", where " $\text{mod}(X, Y)$ " indicates a remainder resulting from division of " $X$ " by " $Y$ ", and " $N$ " represents the number of addresses existing in the memory space extending from the address  $A_0$  to the address  $A_{N-1}$ . Further, " $L$ " represents a value  
20 which can be determined in advance or alternatively the value contained in the capture start command issued by the location determining signal processing module 103. Further, the received signal memory control module 120 records as a packet detection address the address  $A_p$  at  
25 which the received signal has been written when the message of packet detection was received from the packet detecting module 121. In addition, the received signal memory control module 120 records as a packet

detection timing the timing  $T_p$  indicated by the clock 107 when the message of the packet detection is received from the packet detecting module 121.

Alternatively, the received signal memory control

5 module 120 may be so arranged as to record as a capture end address the address " $\text{mod}(A_p + L, N)$ " at the timing when capturing of the received signal is terminated while recording as a capture end timing the timing  $T_{ce}$  indicated by the clock 107 when capturing of the  
10 received signal is stopped. In this conjunction, it should also be mentioned that the received signal memory control module 120 may be so arranged as to record instead of recording the timings  $T_p$  and  $T_{ce}$  mentioned above the timing indicated by the clock 107  
15 when capturing of the received signal was started and a count value resulting from counting the number of times the received signal has been written at the address  $A_0$  during the period or session extending from the start of capturing the received signal to the end thereof.

20           Upon completion of capturing the received signal in the received signal memory 102, the received signal memory control module 120 issues to the terminal location determining signal processing module 103 via the signal line 105 a message of completion of the  
25 received signal capturing as well as the timings indicated by the clock 107 and the addresses of the received signal memory 102 as recorded in the course of execution of the received signal capture stopping

method described above.

In response to reception of the capture end message mentioned above, the terminal location determining signal processing module 103 reads out  
5 sequentially the received signals from the received signal memory 102, starting from the temporally earliest received signal.

More specifically, when the capture stopping method according to the first embodiment of the present  
10 invention is adopted, the terminal location determining signal processing module 103 reads out the received signal from the received signal memory 102, starting from the packet head address  $A_s$  informed when the capture end message is sent from the received signal  
15 memory control module 120 up to the address  $A_{s-1}$  in accordance with the access control method illustrated in Fig. 2.

on the other hand, when the capture stopping method according to the second embodiment of the  
20 present invention is adopted, the terminal location determining signal processing module 103 reads out the received signal from the received signal memory 102, starting from an address  $A_{E+1}$  which succeeds to the packet end address  $A_E$  informed upon reception of the  
25 capture end message from the received signal memory control module 120 up to the address  $A_E$  in accordance with the access control method described hereinbefore by reference to Fig. 2.

Furthermore, when the capture stopping method according to the third embodiment of the present invention is adopted, the terminal location determining signal processing module 103 arithmetically determines  
5 at first the address " $\text{mod}(A_p+L, N)$ " written upon completion of the received signal capturing on the basis of the packet detection address  $A_p$  informed by the capture end message from the received signal memory control module 120. Alternatively, in the case where  
10 the capture end address " $\text{mod}(A_p+L, N)$ " is informed in the capture stopping method according to the third embodiment of the present invention, this address may be used intactly as the write address at the end of the capturing process. In succession, the terminal  
15 location determining signal processing module 103 reads out the received signal, starting from the address which succeeds to the write address at the end of the capturing process, i.e., the address " $\text{mod}(A_p+L, N)+1$ ", up to the address " $\text{mod}(A_p+L, N)$ " in accordance with the  
20 access control method described hereinbefore in conjunction with Fig. 2.

After having read out the received signal by resorting to the method described above, the terminal location determining signal processing module 103  
25 executes the signal processing required for arithmetically determining the position or location of the mobile terminal as in the case of the conventional access point apparatus (base station) described

hereinbefore, the result of which is transferred to the server 6 shown in Fig. 9. At this juncture, it should be noted that the signal processing mentioned above is executed by using the timings at which the leading and  
5 trailing edges of the packet were detected or alternatively the timing at which the packet being received was detected. As the signal processing required for the terminal locating arithmetic, there can be mentioned arithmetical determination of the  
10 timing at which the signal from the terminal was received or the delay profile for computing the reception timing or the like. For the arithmetic determination of the delay profile, the matched filter, for example, may be employed. Furthermore, for  
15 arithmetically determining or computing the reception timing of the received signal on the basis of the delay profile as acquired, there may be adopted a method disclosed in e.g. JP-A-2002-14152. Alternatively, the stored received signal may be intactly transferred to  
20 the server 6 without executing any particular processing on the received signal held in the received signal memory 102.

The server 6 arithmetically determines the position or location of the terminal in accordance with  
25 a method similar to that mentioned hereinbefore in conjunction with the background techniques.

Alternatively, capturing of the packet may be stopped after lapse of a predetermined time since the

timing at which the packet was detected. By way of example, in the case of the first embodiment of the present invention, the packet capture may be carried out till the time taken for receiving one packet after  
5 detection of the packet has elapsed. Further, in the case of the second embodiment of the present invention, the packet capturing may be carried out until the time determined by subtracting the time period for averaging the received power from the time taken for receiving  
10 one packet has elapsed after the packet detection.

Owing to the teachings of the present invention described above, the memory capacity packaged in the access point apparatus (base station) for capturing the received signal can be reduced, which of  
15 course leads to cost reduction of the access point apparatus and hence to reduction of cost involved in the location information service provided by the wireless LAN system while enhancing the serviceableness and profitability thereof.

20 An example of the memory capacity reduction will be described below in the concrete.

By way of example, let's consider detection of the location of a terminal in a system implemented in conformance with the Wireless LAN Standards  
25 IEEE802.11b. According to the Standards IEEE802.11b, each of the individual packets ordinarily has a length or duration on the order of 0.2 msec. to 19 msec. in dependence on the amount of data and the transmission

rate. When the packet of about 1 msec. is employed for locating the terminal (i.e., for determining the position or location of the terminal), the packet mentioned above corresponds to the memory capacity of  
5 0.7 Mbits on the assumption that the sampling frequency is e.g. 44 MHz and that the bit width of in-phase component and quadrature component, respectively, is e.g. 8 bits.

In the case where the location detection is  
10 performed by using the above-mentioned packet, the memory employed in the conventional access point apparatus (base station) for capturing the received signal is required to have the capacity capable of storing the received signal at least for a session of  
15 about 200 msec. in consideration of the time taken for the communication between the server and the access point apparatus as well as the communication between the access point apparatus and the terminal and additionally the delay time of the packet which depends  
20 on the traffic volume on the network. On the above assumption that the sampling frequency is e.g. 44 MHz and that the bit width of in-phase component and quadrature component, respectively, is e.g. 8 bits, the packet mentioned above corresponds to the memory  
25 capacity of 140 Mbits.

By contrast, in the case of the access point apparatus (base station) implemented in accordance with the teachings of the present invention, it is

sufficient that the memory for capturing the received signal has a capacity capable of storing the received signal of the duration twice as long as the packet length or 2 msec. at maximum, which means that the  
5 memory capacity is 1.4 Mbits on the sampling conditions mentioned above. The reason why the capacity exceeds the packet length can be explained by the fact that the response performance and margin involved in the packet detection has to be taken into account. It is thus  
10 apparent that according to the teachings of the present invention, the capacity of the memory for capturing the received signal in the access point apparatus can be reduced by a factor of 1/100 or so when compared with the hitherto known access point apparatus.  
15           It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the invention, the invention is not limited thereto and various changes and modifications may be made without  
20 departing from the spirit of the invention and the scope of the appended claims.